Aviation Environmental Design Tool (AEDT)

Continuous Descent Approach (CDA) Capability Demonstration

Federal Aviation Administration

Presented to: CDA Workshop, NASA Ames

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Motivation

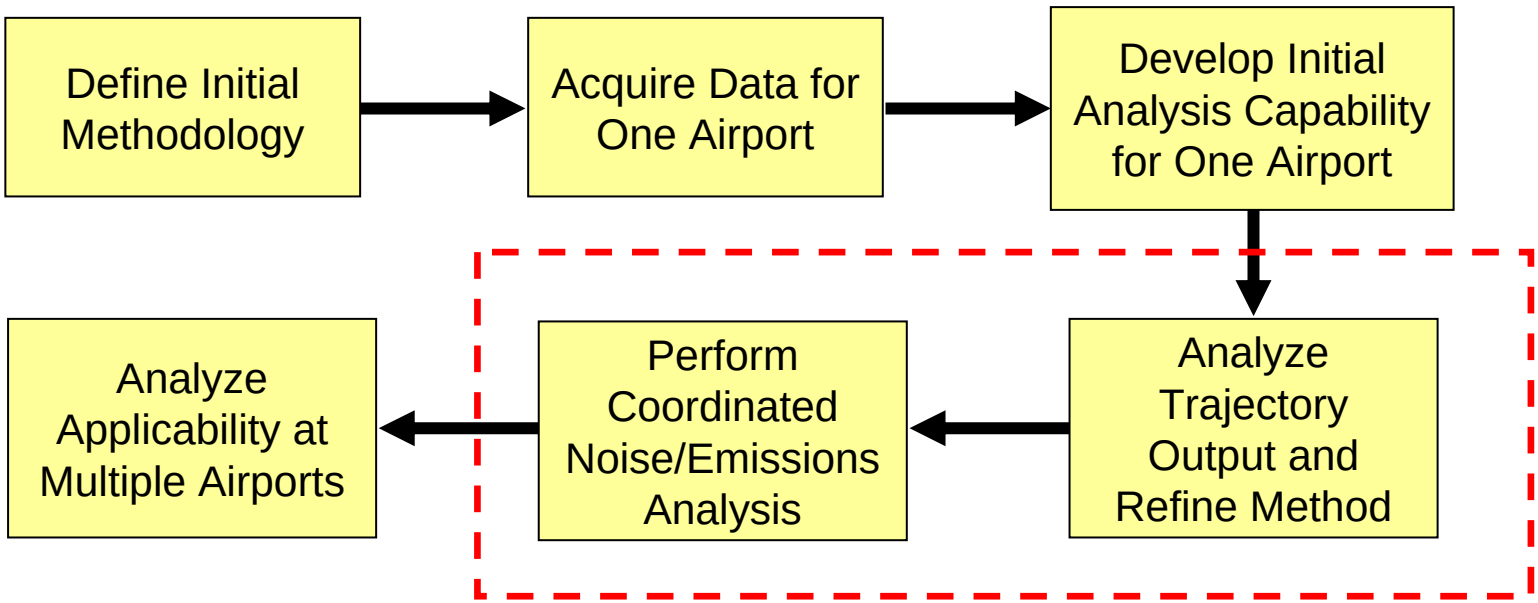
- **FAA/PARTNER Center of Excellence sponsors research in Continuous Descent Approach (CDA) Operational Studies:**
  - Quantified environment effects in 2002 flight test
  - Air traffic control operational proofing in 2004 flight test
  - Demonstrations identified reduced noise, fuel burn, engine emission and time savings (Louisville CDA study: Report No. PARTNER-COE-2005-002, January 2006)

- **Modeling CDA offers an alternative aircraft operational flight procedure for targeted environmental mitigation**

- **Establishing this capability in AEDT allows for:**
  - Modeling real-world, wide-scale environmental benefits (gate-to-gate effects)
  - Projecting cost/benefits of future CDA implementation

CDA Demonstration Development

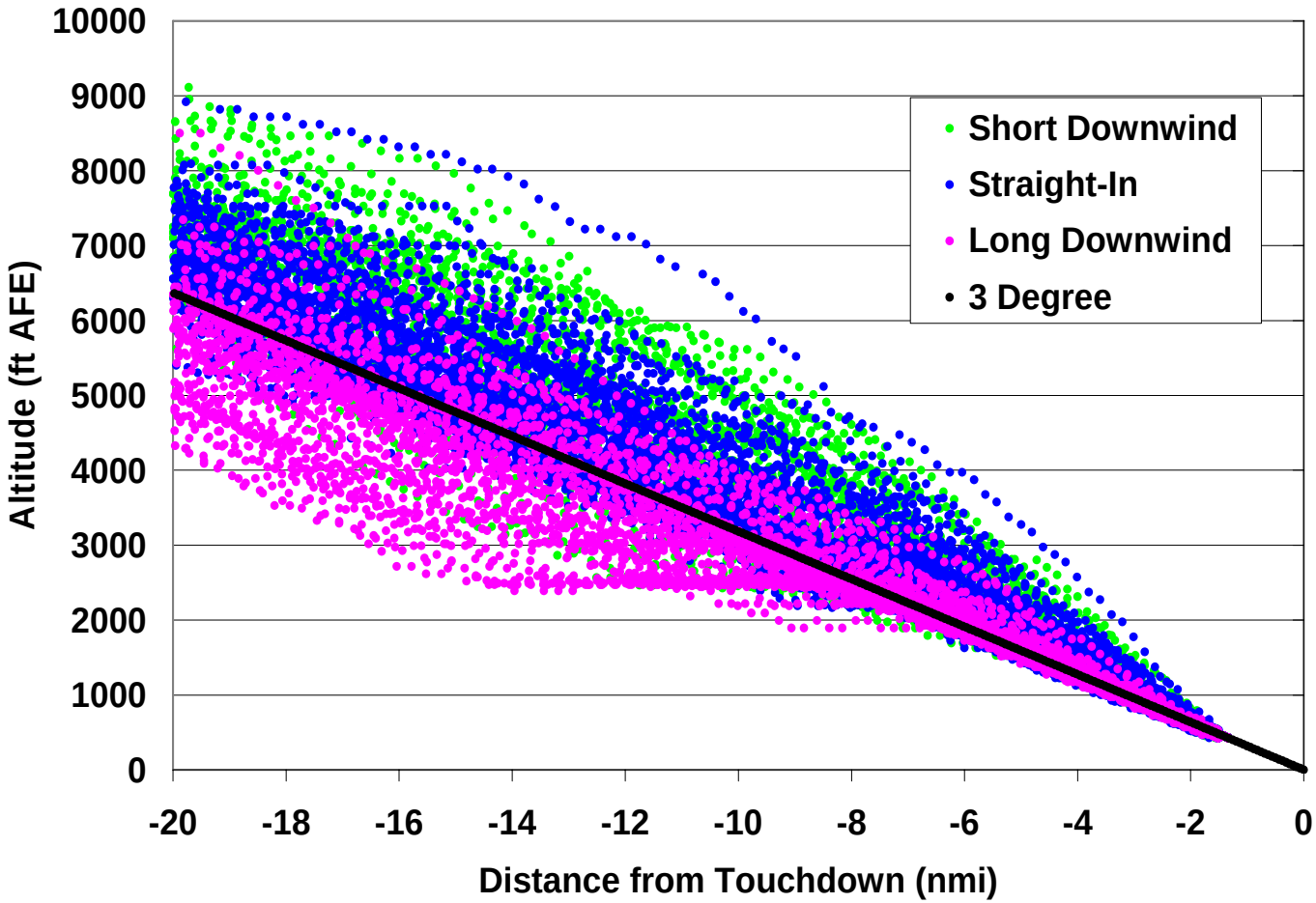
- **Capability Demonstration is still underway:**



Current Analysis

- **Terminal area only, 10,000 ft AFE and below**
- **Baseline operations and trajectories derived from 24 days of radar data**
  - 2 days from each of 12 consecutive months (2005)
  - All available flight paths modeled
  - Airframe/engine combination assignments based on Bureau of Transportation Statistics (BTS) and BACK registration data
  - All operating configurations, both arrivals and departures
- **CDA operations and trajectories derived from 14 days of radar data**
  - 14 consecutive days (April 2006)
  - Both hypothetical and actual CDA implementation levels
  - Aircraft-type specific CDA trajectories modeled based on actual trajectories
- **Future rounds of analyses will include expanded scope**
  - CDAs from top of descent, gate-to-gate effects

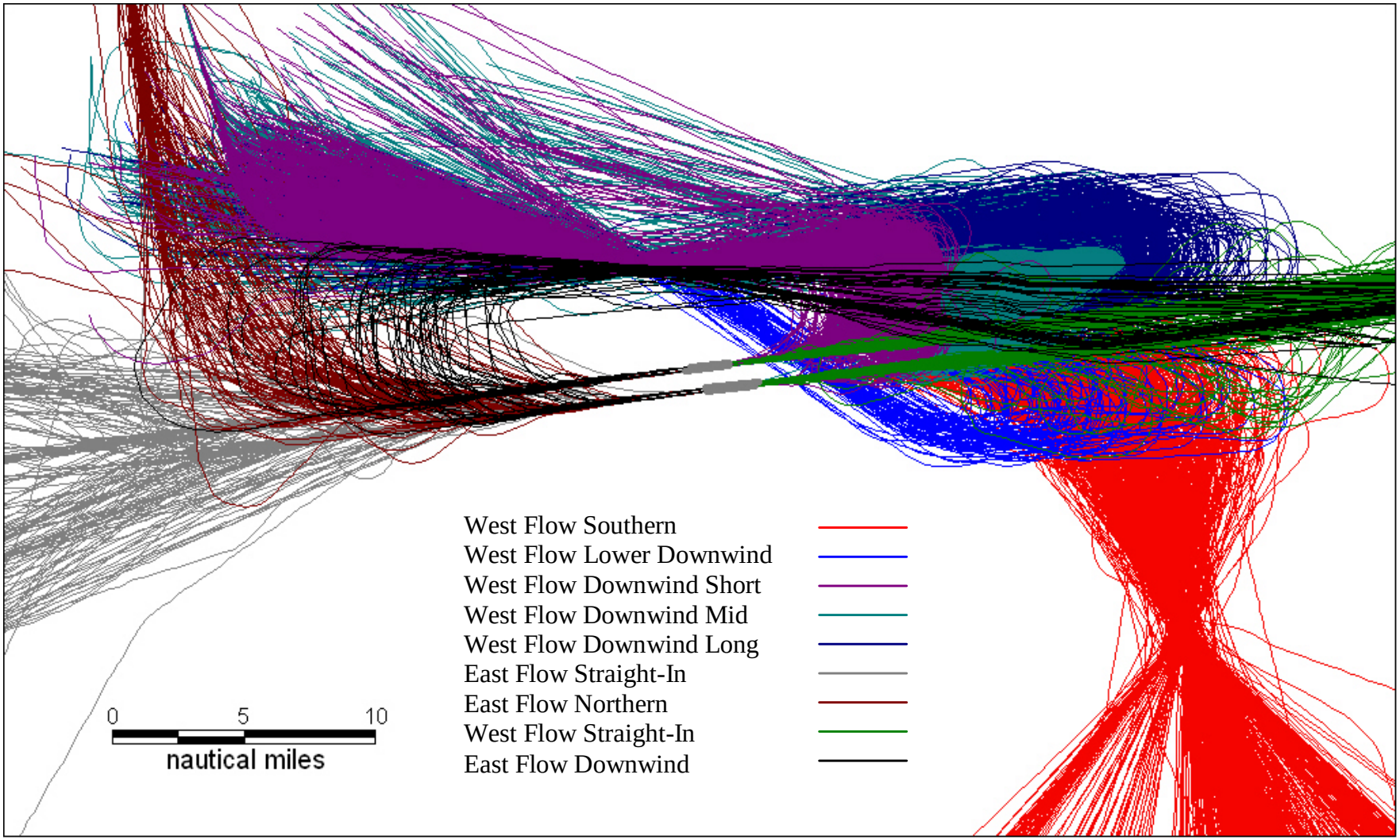
Typically Modeled vs. Actual Approach Profiles



Baseline Approach Profiles

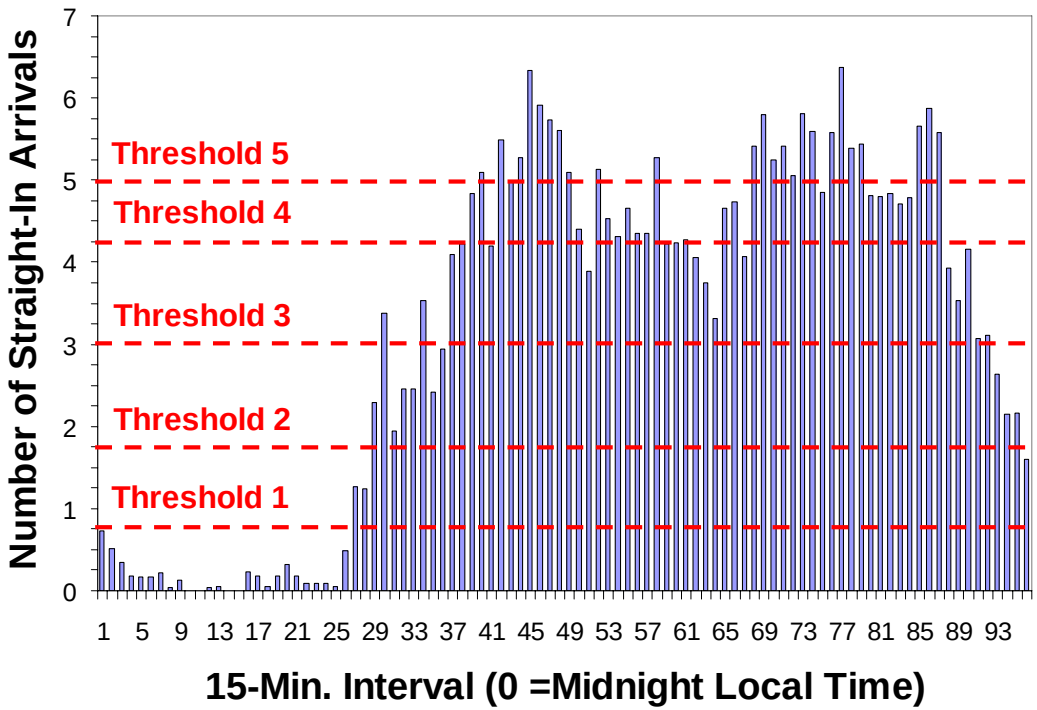
- **Radar is the best widely available data source for current baseline approach trajectories**
- **Requires derivation of thrust levels in order to be used for environmental modeling**
  - No standardized method exists
  - Requires aircraft performance data that is missing from available databases for several important aircraft
- **Society of Automotive Engineers (SAE) A-21 committee has recently formed a Project Working Team to address the issue**
  - Current CDA Demonstration methodology to serve as the basis for guidance document development

Approach Routes



CDA Implementation Levels

- **Six scenarios using hypothetical implementation levels ranging from current baseline to all-CDA operations using traffic flow thresholds**
- **Two scenarios using actual CDA implementation levels**



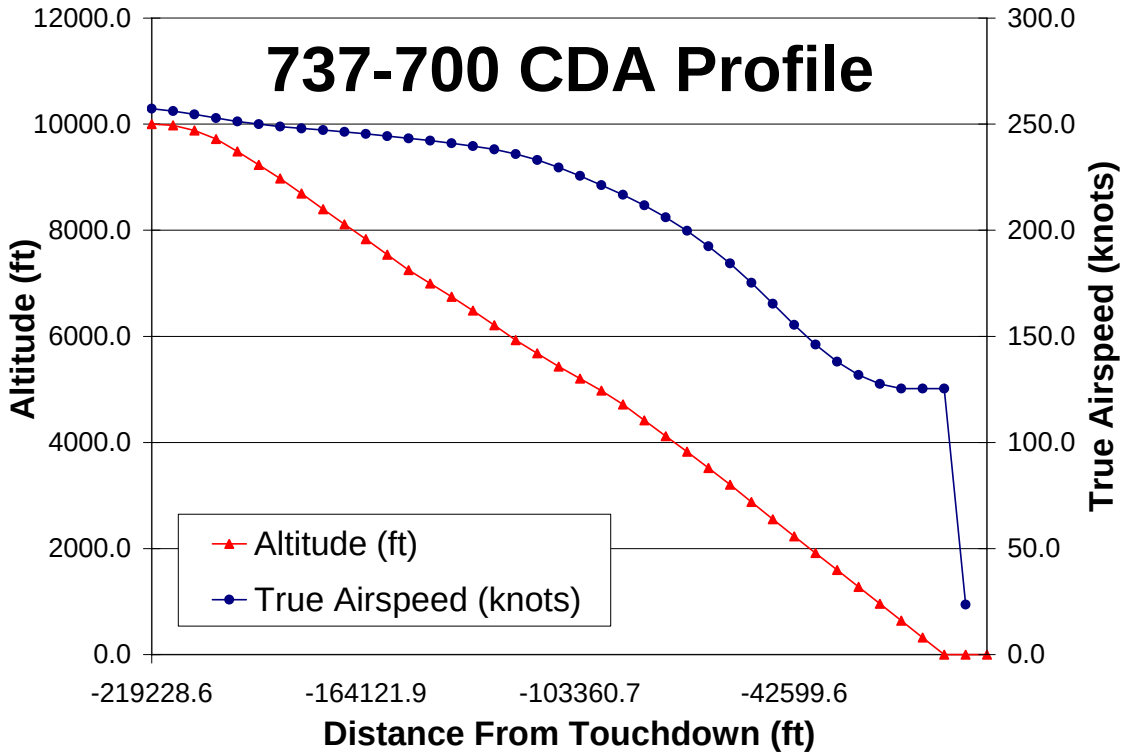
Scenario	Percentage of Total Arrivals Flying CDA's
Baseline	0.0%
Threshold 1	16.3%
Threshold 2	30.4%
Threshold 3	47.8%
Threshold 4	63.3%
Threshold 5	78.8%
All CDA	100.0%
Realistic CDA	17.3%
Actual CDA	17.3%

Actual CDA Implementation Scenarios

- **“Realistic CDA” Scenario**
  - Actual CDA arrival levels applied to 24-day pre-implementation radar data set
  - Operations normalized for consistency across time periods (Day, Evening, Night)
  - Identical fleet mix and non-CDA operations
- **“Actual CDA” Scenario**
  - Based directly on the 14-day post-implementation radar data set
  - Fewer total flight trajectories (14 vs. 24 days worth)
  - Operations normalized for consistency across time periods (Day, Evening, Night)
  - Similar but not identical fleet mix
  - Accounts for all airspace changes

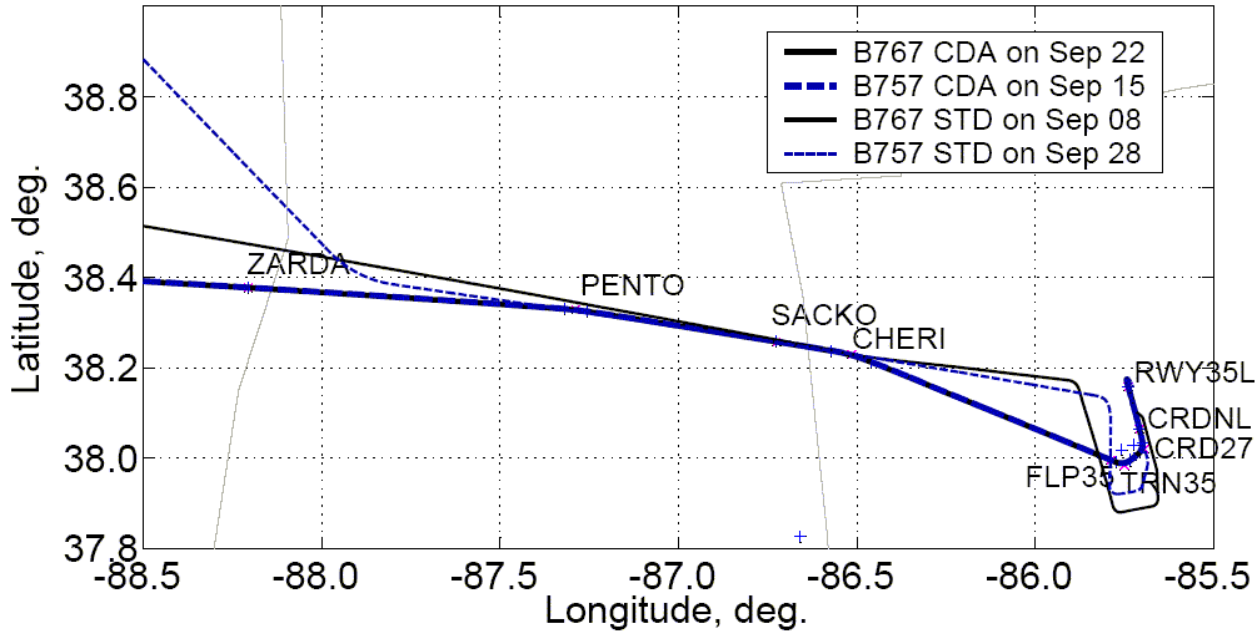
CDA Profiles

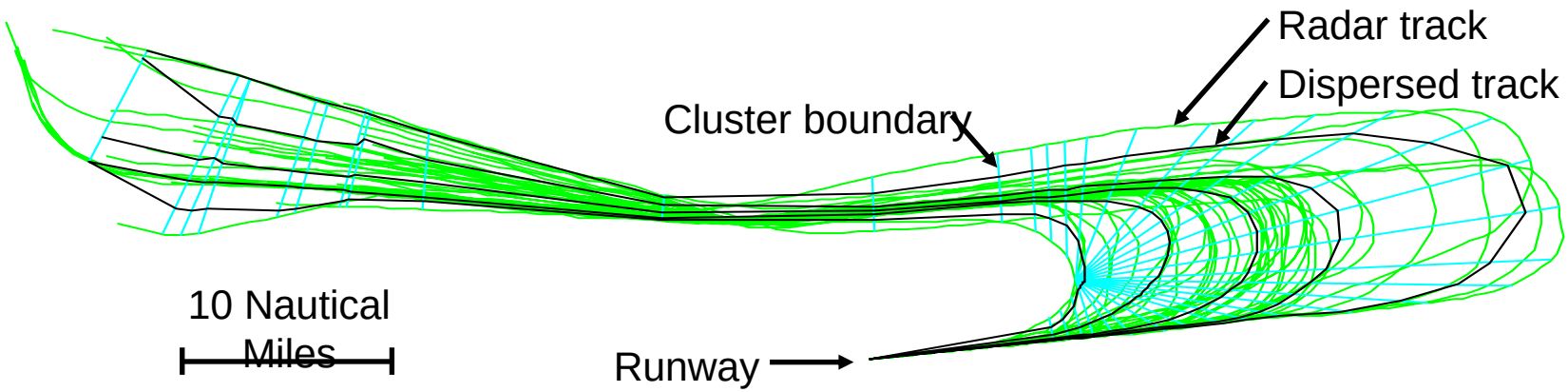
- **Modeled CDA profiles based on actual observed profiles from post-implementation radar data set**
- **Aircraft-type specific profiles, speed schedules based on operation-specific aircraft weight**



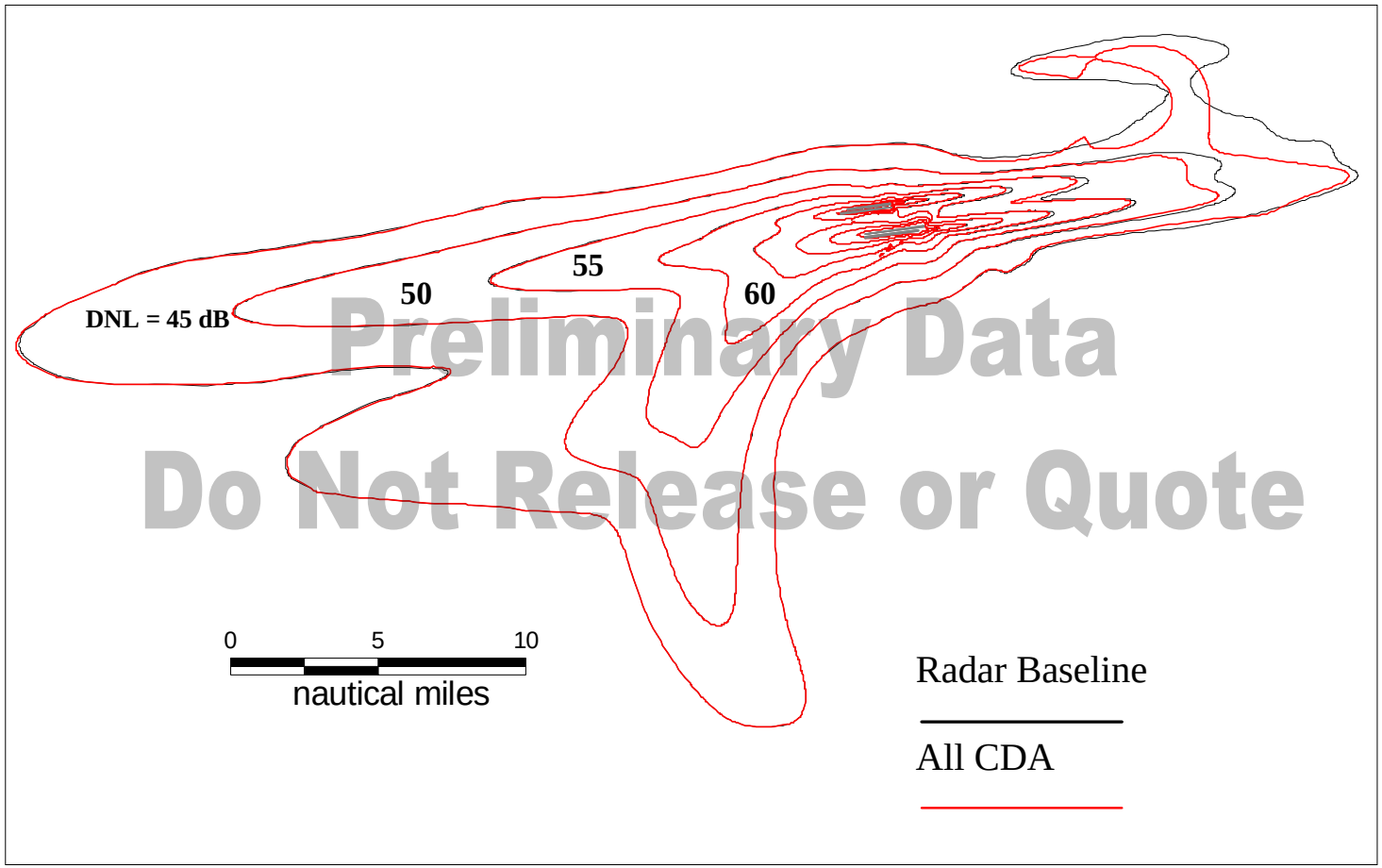
CDA Ground Tracks

KSDF





Day-Night Average Noise Level (DNL) Contour Impacts



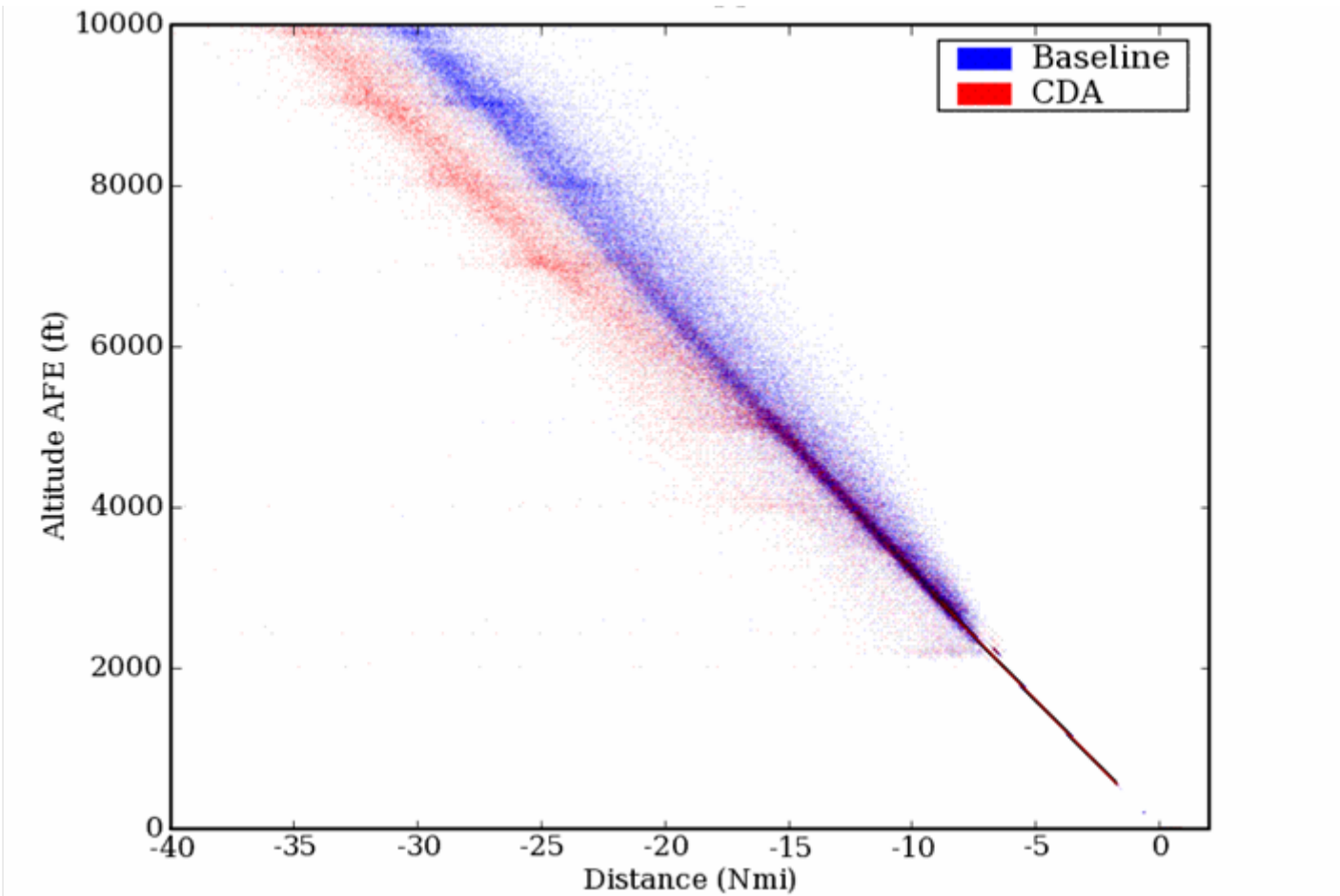
Contour Area Comparisons

Arrivals Only

DNL (dB)	% Change in Area Relative to Baseline							
	Threshold 1	Threshold 2	Threshold 3	Threshold 4	Threshold 5	All CDA	Realistic CDA	Actual CDA*
45	-8.0%	-14.1%	-19.7%	-20.0%	-20.0%	-20.2%	-0.2%	13.7%
50	-4.3%	-6.6%	-9.0%	-9.5%	-9.7%	-10.0%	-0.5%	8.3%
55	-2.8%	-4.3%	-5.9%	-6.6%	-6.9%	-7.4%	-0.6%	4.8%
60	-1.7%	-2.6%	-3.7%	-4.4%	-4.6%	-5.0%	-0.7%	3.3%
65	-0.7%	-1.2%	-1.9%	-2.2%	-2.4%	-2.6%	-0.3%	2.6%
70	-0.8%	-1.5%	-2.2%	-2.6%	-2.9%	-3.5%	-0.5%	2.4%
75	0.4%	0.0%	0.4%	0.4%	0.4%	0.4%	0.0%	3.7%
80	-2.0%	-2.0%	-2.0%	0.0%	0.0%	-2.0%	-2.0%	3.9%

* Modeled increase influenced by unaccounted for non-standard aircraft configurations during baseline straight-in arrivals

Straight-In Arrivals Post CDA Implementation



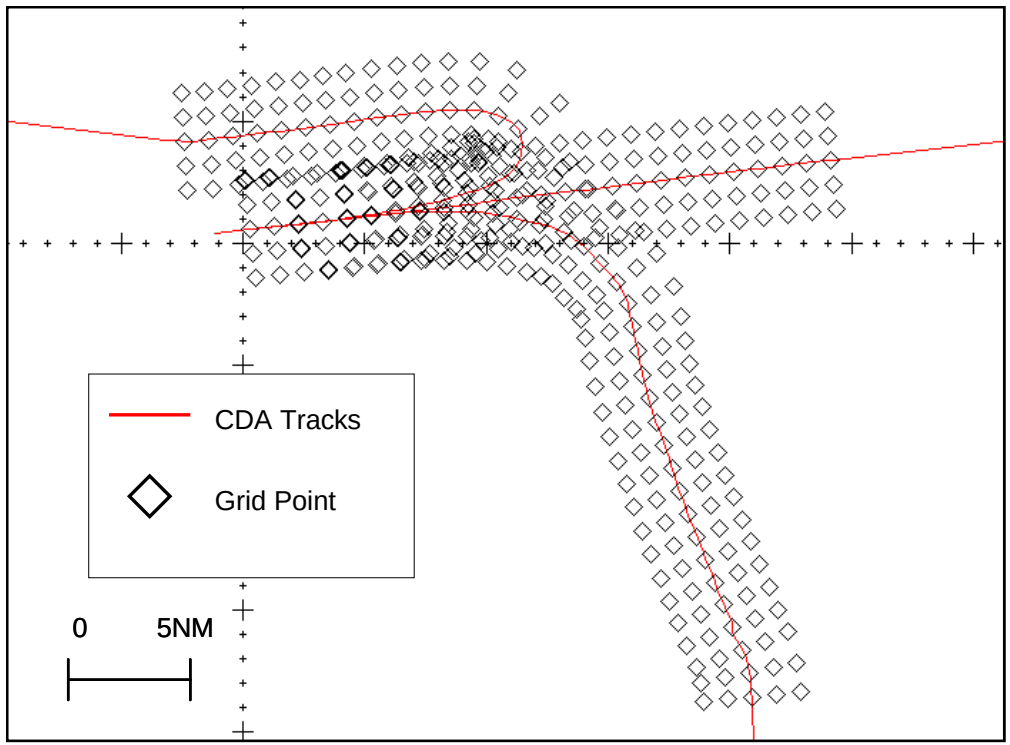
Contour Area Comparisons

Arrivals and Departures

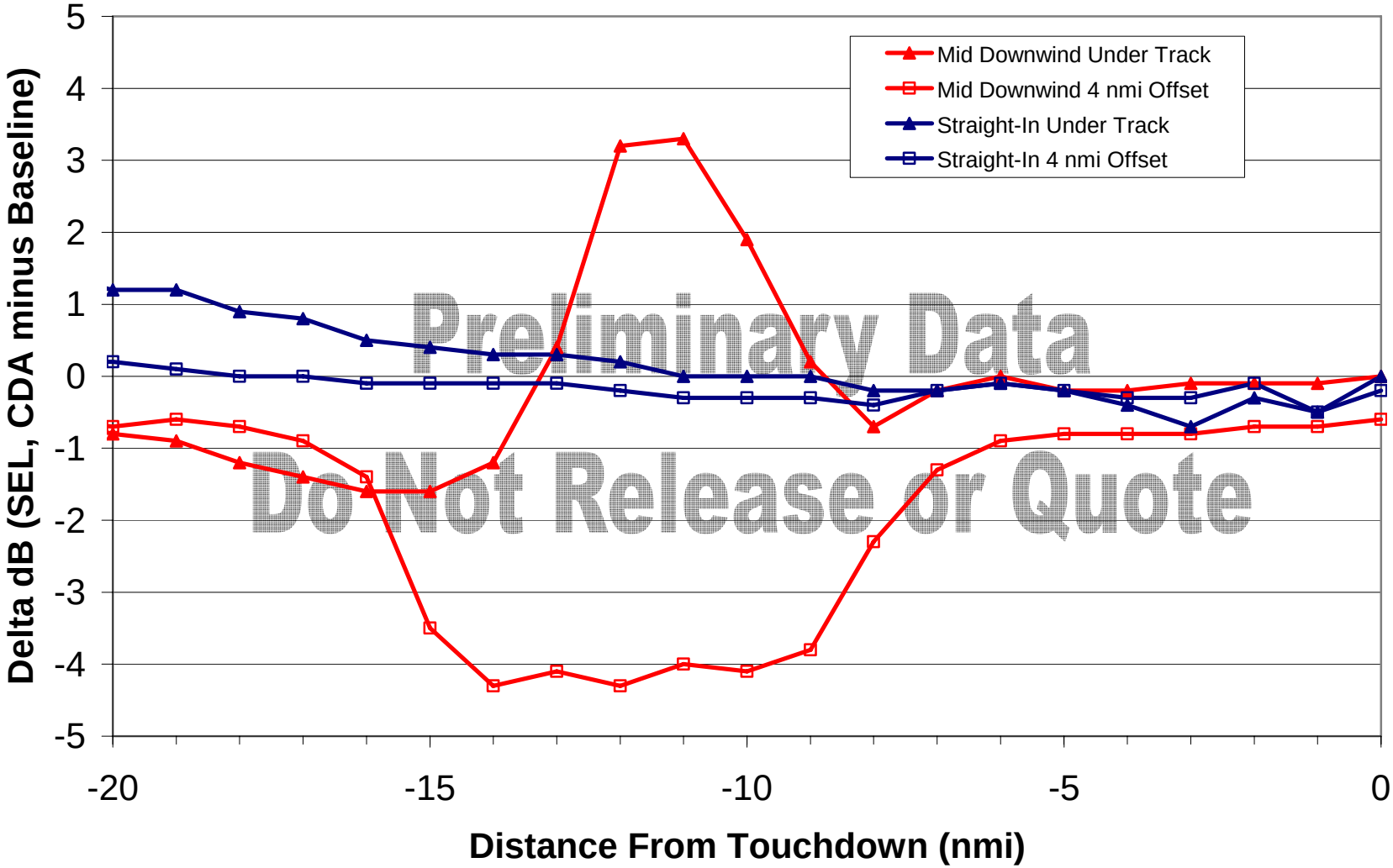
DNL (dB)	% Change in Area Relative to Baseline							
	Threshold 1	Threshold 2	Threshold 3	Threshold 4	Threshold 5	All CDA	Realistic CDA	Actual CDA
45	-1.4%	-2.7%	-3.9%	-4.0%	-4.0%	-4.0%	0.0%	-8.1%
50	-0.8%	-1.3%	-1.7%	-1.8%	-1.9%	-2.0%	-0.1%	-5.0%
55	-0.7%	-1.0%	-1.3%	-1.4%	-1.5%	-1.6%	-0.1%	-4.3%
60	-0.4%	-0.7%	-0.9%	-1.0%	-1.1%	-1.2%	-0.1%	-4.7%
65	-0.2%	-0.4%	-0.5%	-0.6%	-0.6%	-0.7%	-0.1%	-5.0%
70	-0.2%	-0.3%	-0.4%	-0.5%	-0.6%	-0.7%	-0.1%	-3.9%
75	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-5.7%
80	-0.1%	-0.3%	-0.1%	-0.2%	-0.1%	0.0%	-0.2%	-8.2%

A-Weighted Sound Exposure Level (SEL) Grid Points

- **Grid points can help determine noise impacts of both vertical profile and horizontal track differences per approach route**



SEL Comparisons



Fuel Burn and Emissions

10,000 ft AFE to Touchdown

Arrivals and Departures

	Percent Change from Baseline								
Scenario	CO	THC	NMHC	VOC	NOX	SOX	PM10	PM25	FUEL
Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Threshold 1	-4.5%	-0.1%	-0.1%	-0.1%	-0.8%	-1.7%	-0.6%	-0.6%	-1.7%
Threshold 2	-6.4%	-0.2%	-0.2%	-0.2%	-1.2%	-2.7%	-1.0%	-1.0%	-2.7%
Threshold 3	-7.4%	-0.2%	-0.2%	-0.2%	-1.7%	-3.6%	-1.3%	-1.3%	-3.6%
Threshold 4	-5.0%	0.0%	0.0%	0.0%	-1.7%	-3.7%	-1.3%	-1.3%	-3.7%
Threshold 5	-2.5%	0.2%	0.2%	0.2%	-1.8%	-3.7%	-1.3%	-1.3%	-3.7%
All CDA	0.8%	0.5%	0.5%	0.5%	-1.9%	-3.7%	-1.4%	-1.4%	-3.7%
Realistic CDA	2.3%	0.1%	0.1%	0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Actual CDA	10.2%	-11.7%	-11.7%	-11.7%	-6.9%	-4.1%	-2.6%	-2.6%	-4.1%

Current Limitations

- **Using only standard aircraft configuration schedule**
  - Radar does not provide aircraft configuration
  - Modeling capability is there but need information from outside sources
- **Limited aircraft performance data**
  - EUROCONTROL currently working with Airbus to supply necessary data for entire Airbus fleet, FAA working on additional Boeing data
- **Limited use of wind data**
  - Need to balance accuracy requirements vs. publicly available wind data sources

Summary

- **New modeling methods being developed and applied**
  - Use of actual trajectories enables determination of real-world CDA benefits
  - Methods still being refined and require validation
  - Working in conjunction with technical groups such as SAE A-21
- **Limited scope analysis completed**
  - Terminal area only, no use of additional flight procedure information
- **Analysis scope will be increased and repeated at multiple airports**

Next Steps

- **Obtain and incorporate additional aircraft performance data**
- **Support development of and incorporate standardized methodology for deriving thrust from aircraft position data**
- **Develop guidance on appropriate vertical dispersion techniques**
- **Evaluate CDA Demonstration methodology at a number of airports**
- **Develop method for concurrent display of noise and emissions results**
- **Perform significant validation work on any new computational methods developed**

??? Questions ???

FAA Environmental Tools web site:

http://www.faa.gov/about/office_org/headquarters_offices/aep/models/

Verification and Validation

- **Modeling simplifications such as vertical dispersion need to be validated against results using all data at several airports**
- **Methods for calculating thrust from RADAR data can be enhanced and validated using Flight Data Recorder (FDR) information, preliminary efforts have already been completed**
  - Comprehensive FDR data sets are being obtained
  - SAE A-21 PWT efforts will directly support this

Fuel Burn and Emissions

10,000 ft AFE to Touchdown
Arrivals Only

	Percent Change from Baseline								
Scenario	CO	THC	NMHC	VOC	NOX	SOX	PM10	PM25	FUEL
Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Threshold 1	-6.0%	-2.0%	-2.0%	-2.0%	-11.9%	-11.2%	-8.8%	-8.8%	-11.2%
Threshold 2	-8.4%	-3.0%	-3.0%	-3.0%	-19.4%	-17.7%	-14.0%	-14.0%	-17.7%
Threshold 3	-9.7%	-3.1%	-3.1%	-3.1%	-26.2%	-23.5%	-18.3%	-18.3%	-23.5%
Threshold 4	-6.6%	-0.7%	-0.7%	-0.7%	-27.4%	-23.8%	-18.8%	-18.8%	-23.8%
Threshold 5	-3.3%	2.8%	2.8%	2.8%	-28.3%	-23.9%	-19.1%	-19.1%	-23.9%
All CDA	1.0%	8.5%	8.5%	8.5%	-30.0%	-24.2%	-19.8%	-19.8%	-24.2%
Post CDA	16.8%	10.9%	10.9%	10.9%	10.1%	11.0%	11.9%	11.9%	11.0%
Actual CDA	3.1%	2.4%	2.4%	2.4%	-1.2%	-0.3%	-0.5%	-0.5%	-0.3%